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‘DOWN-STREAM’ NETWORK CHARACTERISTICS, BROKER FUNCTIONS AND NEW PRODUCT DEVELOPMENT SUCCESS

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ABSTRACT

Success of product development measured by new product introductions to the market is a key performance indicator for business today. Often internal processes are mentioned in relation to product development optimization. However, the external environment is also critical for product development success. Insights from the alliance and network literature point to benefits such as access to knowledge and capabilities, which enable the firm’s innovative processes. In particular, effects of network relations are analyzed focusing front-end discovery phases of NPD processes. Here, it is observed that small entrepreneurial start up company’s supply knowledge to network alliances with well-established and financially strong companies. However, in the later stages of development the main influence of external partnerships is described as financial support and joining distribution efforts, rather than knowledge sharing as main motivator for engaging in cooperative network or alliance efforts. Extending this perspective, not the least the user-driven innovation research has emphasized the important input to new product development provided by users. While integration with this ‘down-stream’ partner can provide valuable information for the early stages of product development – even triggering substantial innovation – forming relations to customers and users can in many industries have the character of not only a knowledge input, but also knowledge sharing through a community of practice of professional peers. Such network formations between firms and its customer base may then also contribute to later stage product development tasks.

It is the main proposition of this research that characteristics of the network between the focal firm and its customer or market partners will impact the performance of later stage product development tasks. While networks can be characterized by a number of measures like breadth, density, and structural characteristics, more recent developments in network and alliance management need to be specifically accounted for. In particular, it is observed that companies today often integrate a ‘mediator partner’, brokering the external relations, including connection to customers.

This study will explore this field of research focusing on the pharmaceutical industry. As such, this study addresses a gap in the literature concerning the relation to hospital partners influencing the later stages of development. Hospitals and medical centers are the main costumers of new drugs, and they also form a collaborative partnership in the product development phases of clinical trials, where new products are tested before obtaining market approval. Hospitals and medical centers have unique knowledge of the therapeutic area of the new products, and relations to a large number of patients, which is essential for clinical trial recruitment.

The relations between hospitals and pharmaceutical companies have however been changing over the last years, as brokering agents are becoming an increasingly important part of the system, the so-called Contract Research Organizations (CROs). Therefore, the pharmaceutical industry is an interesting case for exploring the influence of multilevel network relation's influence on product approvals.

In this paper, the connection between network alliances and development success is studied through a systemic literature analysis. We review the network and alliance management literature and combine it with research from the industrial marketing field focusing on downstream cooperation management to develop research propositions. To add richness to our conceptual model, we further include qualitative case studies supporting grounded theory building.

In sum, this paper contributes to the literature by the following: (1) We develop a systematic overview over network characteristics shown to have impact for new product development. (2) We discuss how recent developments of management practice, with respect to integrating broker functions in network and alliance management, alter the relationships between network characteristics and new product development and performance, and (3) We focus 'down-stream networks' and, thus, develop research propositions for effective customer input in later stage product development.

INTRODUCTION

The perception that a company's in-house resources alone can develop unique new products is changing. Today companies are pursuing resources in their external network to optimize the knowledge and expertise necessary for the development of unique products to the market (Zaheer and Bell 2005). It is recognized that a firm's external network influence firm performance positively by stimulating innovation and learning (Ahuja 2000; Gulati et al. 2000; Burt 1992). Here strategies pursuing alliances have been prevalent in new product development, as a method to access complementary assets and through that optimize processes of product development (Cassiman and Veugelers 2006; Knudsen and Nielsen 2008). However, other actors in the firm's external network are increasingly emphasized as a key resource for input to new product development. Customers and users of potential new products represents a unique opportunity to utilize know-how and need-dynamics, which can stimulate in-house knowledge and learning in product development (von Hippel 1988). The utilization of user insights is especially interesting in the perspective of high-tech industries, as the market often constitutes professionals with unique expertise in the product area, and therefore are an opportunity for companies to tap into cutting edge knowledge.

Often network resources and especially resources related to knowledge exchange and input have been related to up-stream innovation processes (Powell 1996). However, in the down-stream innovation processes external network resources may greatly benefit the firm and is therefore an important factor to consider in late stage development.

With an increase in utilization of external resources a new type of player has entered the network structure. Broker agents have been integrated in the relationship between partners in development networks, which alter the existing processes and are therefore an issue to consider in the management of external resources with the goal of optimizing development capabilities (Howells 2006; Hargadon and Sutton 1997; Bessant and Rush 1995).

To understand the influence of external network relations on product development success this paper focuses on the pharmaceutical industry. Pharmaceutical and biopharmaceutical drug development is an example of an industry increasingly opening up the otherwise closed development process and entering a more external approach to product development. In order to optimize productivity an increase of alliances and licensing partnerships have been evident over the last years. Further, the pharmaceutical industry is an interesting case of down-stream partnerships, as future customers are directly integrated in the processes of product development, as all new products are to be tested on patients before market entry. New product prospects undergo extensive testing phases following strict clinical trials, which are conducted by medical physician and personal at private clinics, health centers, and hospitals.

The testing process is initiated after intensive laboratory research and animal testing. Successful compounds in the discovery and initial development stages enter the next stage of development, the clinical trial phases, where the new products are tested on humans. These clinical trials comprise of three primary stages, phase I – III. The trials intensify with respect to the number of participants throughout the three phases. In phase I there are usually less than 100 participants (i.e. individuals involved in testing the new pharmaceutical product) where safety is the prime goal. Phase II requires 100 – 300 participants, and here efficacy and determination of exact dosage is the main aim. Phase III requires 1,000 or more participants to be included in the trials, where the new products longer term effects are compared to an equivalent benchmark product (Hathaway et al. 2009; US Food and Drug Administration FDA). As patients are a main factor in

the late stages of clinical trials the industry is highly dependent on medical partners, who have access to patients, and the expertise in the therapeutic area of the new drug.

The clinical trial phases have on average a duration of 8 years and cost of succeeding through all clinical phase including expenses for failed entities is estimated to an average of \$ 800 million, which amount to around 50 % of the overall R&D expenses of developing a new drug (DiMasi, 2001; Struck, 1994; DiMasi and Grabowski, 2007; European Federation of Pharmaceutical Industries and Associations Efpia - *The pharmaceutical industry in figures*. 2009 update).

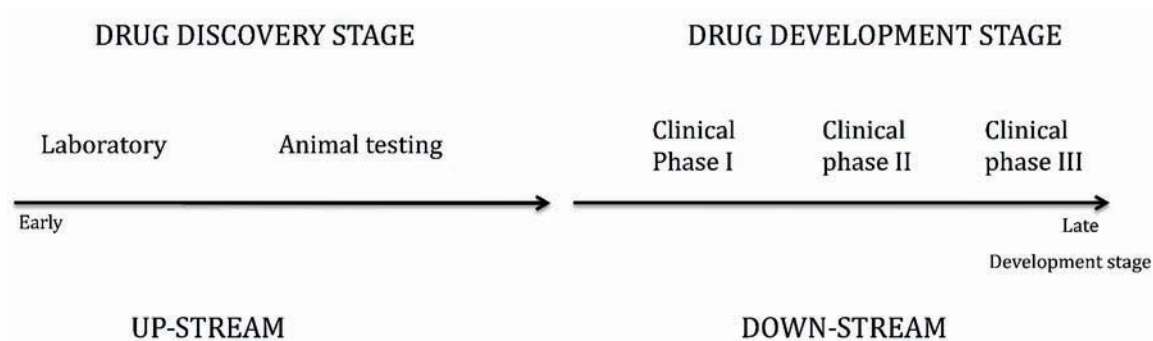


FIGURE 1: *New product development process of the pharmaceutical industry*

The clinical trials are a substantial element in the NPD of the industry due to the extensive time and costs spend on theses stages, and are a continuing challenge to the industry's productivity (The Pharmaceutical Research and Manufacturers of America, PhRMA; FDA). Therefore, the industry has increasingly been focused on opportunities in the external environment to find models for optimizing the complex and resource intensive process of product testing. One of these is the integration of broker agents, referred to in the industry as Contract Research Organizations (CRO), who undertake tasks previous hold in-house in the industry. The product development process will be presented more in detail throughout the progress of the paper.

METHOD

The purpose of this paper is to study the influence of firm's external network relations in down-stream development processes, and discuss the possibilities in high technology industries to tap into unique knowledge amongst external relations such as customers and users. We do this by exploring previous literature on alliance and network management literature and combine it with the field of industrial product development focusing on down-stream processes. Further, the presented structure of network partners in product development are challenged by literature on broker function, and this stream of literature will be applied to discuss how this changes existing dynamics. The literature review will therefore study the role of down-stream network resources in product development by combining perspectives from different fields. First, perspectives from alliance and network theory will be presented in relation to down-stream processes. Second, users as a network resource in product development are presented, including perspectives on communities of practice and the influence of professional network relations. Third, the presented network dynamics are challenged by the introduction of broker agent perspectives.

To add richness to the conceptual framework discussed in the paper, and to challenge the theoretical perspectives, the paper will draw on examples from the pharmaceutical industry. In particular, examples from drug development processes are presented throughout the paper, to provide an empirical approach fit for extending the conceptual model of later stage new product development cooperation. The conceptual model presented in the paper will then lead to a discussion of managerial challenges in down-stream innovation and direction for further research in this field.

DOWN-STREAM NETWORK CHARACTERISTICS

Almost 25 years ago Håkansson and Snehota (1989) declared that ‘*no business is an island*’, presenting an external perspective on strategic management. The perception of a firm with clear boundaries defining firm resources, as presented by the transaction cost economic theory, was thereby challenged (Coase 1937; Williamson 1975). Firm’s capabilities are thereby not limited to in-house resources, but external network relations are perceived as assets, which can be utilized and contribute to firm performance (Gulati 1998; Zaheer and Bell 2005). This is especially the case in the perspective of product development processes, as it is today widely recognize. Firms’ external resources are accepted as an integral element in the development of unique products for the market. Firms cannot rely solely on their internal capabilities when developing new products, but also needs to pool external resources (Gold 1987; Zaheer and Bell 2005).

A company’s external networks of stakeholders are therefore of vast importance for the processes of product development. This is often observed in the up-stream processes of product development, where companies may enter alliances or create licensing agreements in order to tap into complimentary capabilities needed in the research and development of new products (Powell, 1996; Reid and de Brentani, 2004). This can for example be observed in high technology markets when products are discovered and initially developed in one, often smaller entrepreneurial, company, and being further developed in partnerships with another company with complementary capabilities for late stage development tasks. Development resources are thereby acquired in alliances or licensing structures, where financially strong companies tap into new and promising product ideas from smaller companies in the initial discovery phases (Bower 1993; Teece 2000; Pisano 1997).

This trend in new product development is especially prevalent in development of new pharmaceutical and biopharmaceutical products (Deeds and Hill 1996; Bower 1993). New entities are often discovered and initially developed in one company, and then in the later stages of development licensed or an alliance is entered with another, often financially stronger company on the market (Pisano 1997; McCutchen and Swamidass, 2004; Arora et al. 2000; Pisano 2006). From the initial discovery phases in the pharmaceutical industry only one in five thousand succeeds and is therefore considered promising enough to pass on to the clinical trial phases (European Federation of Pharmaceutical Industries and Associations Efpia - *The pharmaceutical industry in figures*. 2009 update). As the success rate of new products through development is distinctively low in this industry, pharmaceutical companies continuously need new promising entities in their product pipeline (Grabowski and Kyle 2007, McCutchen et al. 2008). A strategy of entering alliances with companies with promising entities or licensing an entity after the initial discovery phases has become a popular strategy in the industry to meet the challenge of optimizing the level of promising new entities in the product pipeline (Pisano 1997,

Bower 1993). The strategy of pooling network resources in the discovery phases of product development illustrates how companies are utilizing external resources and not only developing products from internal capabilities in the fuzzy front end.

However, external resources are not only important in up-stream processes. The same examples of alliances between small companies with new discoveries and larger financially strong companies illustrate that in the later stages of development financial capabilities are of vast importance in the pharmaceutical industry. The trial phases in drug development represents the dominant investment in developing new products, as it requires extensive financial capabilities to conduct the time consuming and extensive later stages of development. This is further emphasized by the high risk of failure in the later phases, as the probability of promising new entities from the discovery phases to succeed the three clinical trial phases are only one in five (DiMasi, 2001; DiMasi and Grabowski, 2007). This high level of uncertainty in this very late stage of development makes financial strength an essential asset in order to pursue these down-stream activities. Further, studies on clinical trial experience have shown that companies, who have developed know-how in conducting and managing these phase of development where many regulatory issues are challenging, have a higher success rate (Danzon et al. 2005). Therefore, companies with financial strength and experience in the regulatory requirements in these trial phases are a valuable resource in down-stream innovation and an asset of necessity for smaller companies with less financial strength and experience in down-stream processes.

Studies conducted about network resources in pharmaceutical product development focus mainly on these industrial networks where a company supplies up-stream resources, primarily focused on knowledge input in relation to new entities, and down-stream resources primarily focused on financial capabilities and experience in regulatory processes from partner companies. However, this focus on industrial partners neglects other important actors of influence to the development process. Utilizing user knowledge can be beneficial for the new product development processes, as users have unique insight into product use and user needs and can therefore supply input in the creation and development of new products. In the next part of the paper the role of the user in product development processes will be explored further. The terms ‘users’ and ‘customers’ are applied interchangeable in this paper, however a distinction and more in depth analysis on the difference is a relevant topic for further research, but outside the scope of this paper.

Influence of users in product development

Pooling resources from other companies are not the only external source of input that firms utilize in product development. Von Hippel (1988) expanded the perspective on sources of innovation by presenting users as a main resource for new product developments. He discusses how the perspective on users has changed from actors representing market needs, which industry could try to identify and fulfill, to a perspective on users as having an actual influence on the development process and the final products ready for the market (Von Hippel 2005). Users are seen as an increasing source of input in new product development, contributing to firm performance (von Hippel 2005; Shah 2000; Rothwell 1994). Some users are especially emphasized and defined as ‘lead users’ with unique knowledge about the future end-user market of a new product, as well as specific knowledge on the product area (von Hippel 1986; Urban and von Hippel 1988; Shah 2000). These lead users may have cutting edge knowledge of the product area (Rothwell 1994) through their professional expertise and thereby represent

knowledge of excellence (Shaw 1988), and may even form communities where they share knowledge and learn from each other (Franke and Shah 2002).

The user influence on the development process is often observed in the earlier stages of development where new ideas are discovered. The user-driven perspective of innovation presents the user as a resource with unique need related knowledge and therefore as an important partner in the discovery of new product ideas. Von Hippel (1988) emphasizes that often the user even discovers the actual new idea, develops the prototype and hereafter engages with industry for the late stages of development. The users thereby fulfill their own needs by inventing new products and are a major influence on the pipeline in up-stream innovation. The motive behind this activity by users is driven by their possible gain from the new product by fulfilling a need they define (von Hippel 1988).

Even though the pharmaceutical industry is based on a very high-technology discovery process, indications of up-stream user developments can be observed. Physicians or medical scientists at university hospitals sometimes develop new products, as these actors have expert knowledge on their medical area and also have direct interaction with patients and therefore patient needs. Later in the process these actors or organizations will then often form alliances with private industry in the expensive down-stream processes (Bower 1993).

Besides being an asset in up-stream innovation, users and customers are also a relevant network resource in down-stream innovation processes. Users may be integrated in the later stages of development, when new products are being tested before market launch. Extant literature on user roles in down-stream processes presents the user in relation to prototype development (Shaw 1988) and prototype testing in the late stages of development often conducted for marketing purposes (Thomke and von Hippel, 2002; Cooper 2001). However, there is limited knowledge on the character and scope of user influences in these late stages of development. We therefore turn to the example of the pharmaceutical industry to explore the role of users in down-stream processes.

The role of users in down-stream processes in drug development

The pharmaceutical industry is an interesting example of how users and customers are sometimes highly integrated in the later development processes of new products. Drug development introduces specific examples of influence from users in down-stream innovation processes, and such examples can thereby contribute with perspectives on user input characteristics. In extant literature on user influence in down-stream development such as prototype development and testing processes it is only to a limited degree explained how users actually influence the processes and the scope of this influence (Thomke and von Hippel, 2002; Cooper 2001). There is limited literature exploring the actual input from users in the down-stream process and how this is shared and utilized by the company.

In the pharmaceutical industry an important interaction between in-house staff from companies and users from medical sites during the clinical trial phases occurs. Physicians both in private clinics and in large medical sites such as hospitals are central users of products on the market through their direct relation to patients and their treatment methods. Also physicians have a more direct role in pharmaceutical product development, as they are integrated in the testing of new products, which may give access to the market. The pharmaceutical industry is an unique example of product testing processes, as the new products undergo extensive clinical research processes, where it is required to collaborate with users as they can conduct the actual patient

trials and supply the necessary information for the regulatory authorities. The physician's link to patients is therefore a valuable asset for the pharmaceutical industry, as well as physician's expertise in the therapeutic area, which is needed to conduct and observe trials. The pharmaceutical industry therefore partner-up with medical sites in order to conduct the clinical trials, where the new products are tested for safety and efficacy to acquire approval for market launch (Getz and Zuckerman 2010). Physicians at medical clinics and hospitals collaborate with a company's in-house clinical staff when trials of the new products are conducted. Companies develop trial protocols as well as manuals for product use, which sites apply in the clinical trials. Feedback from the sites on safety and efficacy of the new products are then reported back to the company and entails the application to the regulatory authorities for gaining approval of the new product to the market (Hathaway et al. 2009). Physicians are thereby integrated in the development of new products before market launch, thus presenting an example of how users in some industries are a central player in the down-stream processes.

Previous studies on pharmaceutical product development have pointed to the importance of the relationships to these users for the outcome of trials and market introduction. Danzon et al. (2005) have studied the impact of experience in the trial processes on trial outcome. They found a positive correlation between trial success and experience in the trial processes such as designing and managing trials, and continuous relationships to clinical sites and therefore physicians. This study is interesting, as it illustrates that the process of user integration in the testing process not only is a matter of standardized feedback, but that the actual relationship between users and industry in the down-stream development process are important, and that the network created over time may influence trial outcome. Another example of the influence of users in the trial phases has in previous studies been illustrated in relation to market introduction. Glass (2004) has studied the influence of the relationship to physicians in relation to the adoption of the new products to the market. These studies point to the importance of physician-industry relations, as physicians participating in clinical trials are more likely to prescribe the new product after market launch. Sismondo (2008) discuss this phenomenon and mentions how clinical trials familiarize physicians with the new products, which may impact their behavior in relation to prescribing the new product and therefore influence the performance of the new product on the market.

The role of users in drug development illustrates that ongoing collaboration between user and in-house staff may influence success of clinical trials, as well as adoption of products after market entry. Professional interaction is a central issue describing this interaction as both users and the in-house staff is knowledgeable within the field. Users are highly qualified professionals and in-house representatives are not only marketing personal, but clinical staff with specific product knowledge. The testing process is therefore not only a marketing process but an exchange of specific knowledge determining the new entities possibilities to obtain market approval. Next we will therefore draw on perspectives on professional network interaction between in-house staff and external resources in order to explore the possibilities of users in down-stream development.

Professional network resources

Von Hippel (1988) introduces the term '*informal knowledge exchange*' in relation to utilizing knowledge from professional peers at rival companies. The perspective of information knowledge exchange is also presented in perspectives of coopetition, where competing companies collaborate in often informal relations (Bengtsson and Kock 2000; Dyer and Singh

1998). This perspective introduces insights into the possible influence of external actors as in-house personal may engage in both formal and informal professional interaction to gain new knowledge and exchange professional experiences. In high-technology markets the users are in many cases professionals with unique knowledge not only about user behavior, but also about the field of the specific industry. Therefore user influence in the product development process may not only have character user-need input from user to producer, but the relation can better be characterized as a knowledge exchange among professionals, as industry staff may be from the same professional field as the users. According to Wenger (2000) there exist different social communities of practice where unique knowledge is defined over time and this knowledge becomes social competencies within the community. Such communities are often groups of individuals with competencies within the same profession or area, which over time evolves joint understanding. These social communities together with personal competencies make it possible for new knowledge and innovation to emerge (Wenger 1998): *“In these learning systems, organizations find the talents they need, new ideas, technological developments, best practices, and learning partners”* (Wenger, 1998: 244).

Communities of practice are most often applied to define professional network relations between companies and for example universities or other knowledge centers central for high-technology product development (Lynn et al. 1996). But in high-technology industries products are often disseminated to professionals within the field. The relations to customers and users can in many industries have the character of not only a knowledge input but also knowledge sharing through a community of practice of equal professionals with knowledge of the product area (Wenger 1998). This is also the case in the pharmaceutical industry, where the central users of new products are physicians at medical centers through their relation to patients. The relationship between the in-house clinical staff and the clinical investigators at hospitals has similarities to Wenger (1998) communities of practice. In drug development professional communities of individuals are developed over time, which generate optimal opportunities of knowledge sharing. *Direct clinical participation represents a way for sponsor companies to develop strong relationships with practicing physicians, not only by communicating with potential prescribers, but by learning directly from them as well* (Glass 2004 in Pharmaceutical Executive). As the study from Glass (2004) illustrate, the down-stream network with physicians has a professional impact on the development process, as industry clinical staff and physicians at medical sites interact and exchange knowledge. This is also mentioned by Danzon et al. (2005) in relation to trial experience and the impact of relations to physicians for trial success. *Learning-by-doing may produce general and category-specific skills in designing and managing trials, and improve relationships with clinicians and regulators, thereby contributing to trial success rates* (Danzon et al. 2005, 319). This corresponds with the perspectives mentioned by Wenger (2000) as the communities of practice generating knowledge exchanged are generated over time. The continuous relationship between companies and the physicians developed over time thereby creates conditions, which may generate what von Hippel (1988) identified as informal knowledge exchange, and be a unique source of input to the late stages of development in the pharmaceutical industry. Especially as the development process in drug development are so extensive and conducted over so many years, potential input from clinical sites may influence later stages of development and optimize the process and later commercialization. However, the structure where companies interact directly with physicians in the drug development have seen profound changes over the last years, changes that may challenge the knowledge flow from physicians to the pharmaceutical industry in product development.

The expenses of clinical trials are continually increasing in the pharmaceutical industry even though more products are not entering the market (Kaitin 2010). There is therefore a common understanding in the industry that the extensive time-consuming and costly development process needs to be more effective. These motives have made pharmaceutical companies outsource previous in-house competences, such as site selection and data management, which are both closely connected to the relationship to trials, to a contract research organization (CRO) (Getz and Zuckerman 2008). It has been recognized that the integration of a CRO may generate savings on cost and time (Getz 2007; Kaitin 2010) as these organizations are specialized in the down-stream task of clinical trial management.

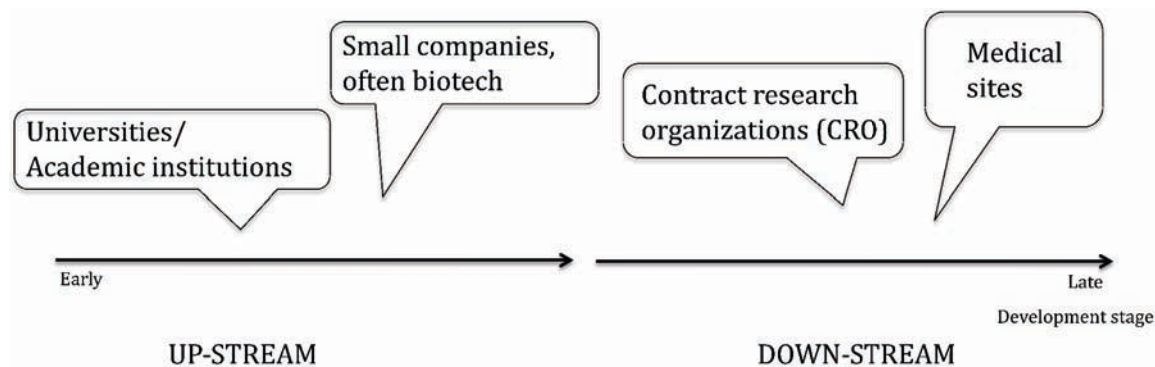


FIGURE 2: Main external resources in the drug development process

The majority of extant literature on increasing influence of CRO partners in pharmaceutical product development focuses in the advantages and challenges from an outsourcing perspective (Metha and Peters 2007; Getz and Zuckerman 2008). The increasing use of CRO services is observed from an outsourcing perspective, as services previously held in-house in the pharmaceutical industry are continuously being outsourced to a second party (Getz and Zuckerman 2008). Outsourcing of central tasks and resources in the development process are also recognized by Howells (1999) and Ringe (1992), who defines the term of Contract Research and Technology Organizations (CRTO) as *...work of an innovatory nature undertaken by one party on behalf of another under conditions laid out in a contract agreed formally beforehand* (Ringe 1992). Applying an outsourcing strategy in product development enables companies to focus on their core capabilities by contracting out tasks, which are not considered to be central to the company's core competences (Howells 1999). In the pharmaceutical industry this has caused an increase in the use of CRO functions in relation to late stages of product development, when products are tested in clinical trials. The use of outsourcing in the late stage of drug development now often included CROs managing the direct relations to trial sites as companies outsource clinical trial processes in a full service partnership (FSP) (Getz and Zuckerman 2008; Bodenheimer 2000). The CRO thereby mediates the relationship between two key actors in drug development and it is therefore relevant to take on a brokerage perspective. Tasks of product development are not only outsourced to a second party, but the CROs are increasingly becoming a third party agent between network relations in the clinical trials. The next part of the paper will therefore turn to the perspective of broker agents and how this expansion of the network

structure may optimize and challenge the down-stream innovation processes in product development.

BROKER AGENTS

With a growing external perspective on new product development a company's external network relations are naturally of great importance. This have brought by new types of organizations assisting companies in their endeavors reaching out to external resources in their development processes. Companies mediating relationships to external stakeholders have entered the product development framework (Howells 2006; Hargadon and Sutton 1997; Bessant and Rush 1995). The role of this third party partner functioning between existing organizations have been defined in different terms, such as *intermediaries* (Shohet and Prevezen 1996; Howells 2006), *consultants bridging a gap* (Bessant and Rush 1995), *superstructure* (Lynn et al. 1996) and *brokers* (Hargadon and Sutton 1997; Could and Fernandez 1989).

These mediators of relations in companies' external environment have thereby also been referred to in relation to different functions in the innovation process. The perspectives of mediators are often presented as being the role of bridging firms and optimizing relations to external resources and partners that otherwise may be difficult for firms to tap into (Bessant and Rush 1995; Hargadon and Sutton 1997). Lynn' (1996) presents a perspective on innovation communities that emphasizes a superstructure of organizations with the role of generating flow of knowledge in a community of technical related organizations. The superstructure is thereby the generator of optimizing knowledge flow or creating conditions for knowledge flow, which may otherwise be limited. The function of brokerage thereby refers to a position in a social network where an actor is connecting other actors in the system, which is not directly tied to each other (Burt 1992; Marsden 1983; Could and Fernandez 1989). Broker function gain a powerful role through its position connecting otherwise not connected ties and thereby obtaining optimal position in a network in relation to information flow, which may influence performance of that player (Burt 1992). Broker agents are therefore filling a structural hole, by being the direct link between two actors, who are only linked through indirect ties, and thereby generating increased influence in the system (Burt 1992). The distinction of direct and indirect ties is further discussed by Ahuja (2000) in relation to learning and knowledge input, as it is suggested that both direct and indirect ties can influence innovation processes, but indirect ties is dependent on the level of direct ties. The position of an actor in relation to other actors in a social network are the key factor influencing performance, and the structure of actors are therefore emphasized more than the individual attributes of these actors (Burt 1992).

Could and Fernandez (1989) criticizes social network perspectives on broker functions (Burt 1976; Galaskiewicz and Krohn 1984) for merely presenting the position of the broker as important and excluding the aim of the brokerage pattern. Could and Fernandez (1989) present five different roles of the broker functions; local broker/coordinator, cosmopolitan/itinerant, gate keeper, representative and liaison. This perspective discuss the position of the broker in relation to the partners whom the broker mediates, and present different relations and thereby roles of the broker. The broker may belong to the same subgroup as one of the other actors, or none of them, and thereby have a different role in relation to this position.

Often intermediary functions are mentioned in relation to up-stream innovation functions, where these partners bridge relations to front-end resources. Intermediaries are found in relation to the linkage of public institutions such as universities, to external and often private organizations

relevant for licensing a new technology or otherwise utilize an idea discovered in a university environment (Shohet and Prevezer 1996). Further, ideas discovered in university environments can be supported by an intermediary function in relation to patent applications and trading (Shohet and Prevezer 1996). However, as discussed in this paper, external assets are also pursued in down-stream processes of innovation, which generate a potential role of mediators. In pharmaceutical down-stream processes the integration of contract research organizations is not just an issue of outsourcing, but brokerage, as the CROs manages tasks between two actors. Further, the example from the pharmaceutical industry illustrates a broker function that mediates a relationship between two actors, who previously had direct interaction in the development process, as the CRO manages tasks and relations between sponsor companies and medical sites. Broker functions in the pharmaceutical product development are therefore not only applied as a mean for companies to gain access to new relations and assets, but third party organizations are integrated between existing collaborative partners to optimize the down-stream development process. The integration of CRO partners in the pharmaceutical industry thereby illustrates how previous direct ties are enforced to become indirect ties, and thereby expands on previous literature on broker functions.

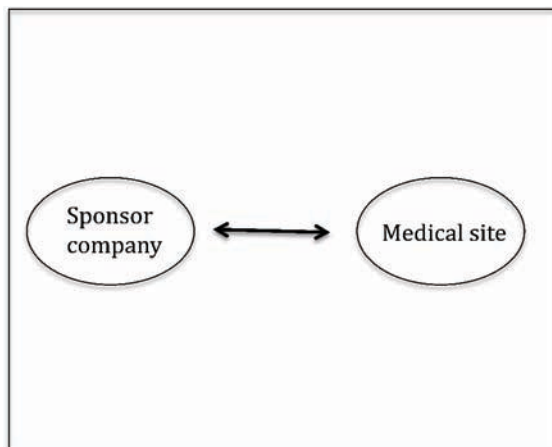


FIGURE 3: *Direct site-industry relations.*

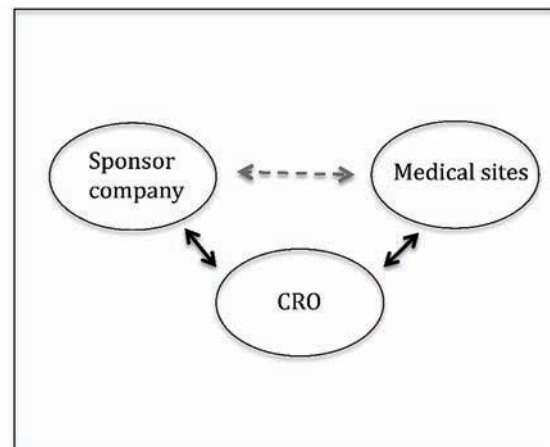


FIGURE 4: *CRO as intermediary agent*

CROs have entered drug development focusing on the late stages of development, where new drug entities enter the clinical trial phases. In the late trial phases CROs are positioned as an organization optimizing trial management such as data management and patient and site recruitment. The task portfolios of CROs have increased since this type of organizations entered drug development about ten years ago. Previous most CRO-sponsor company relationships were based on the CRO conducting functional tasks in a transactional relationship, and therefore an integration of CRO activities on a single task contract, after the development plan and the protocol have been developed. The CRO are therefore integrated to manage some parts of the clinical trial tasks and often the sponsor company still has direct connection to the medical sites and an active part in the central management task (Getz 2009; Getz and Zuckerman 2008). This structure has developed over the years and it can now be observed that in some cases the CRO are controlling an increasing part of the clinical trial tasks and therefore becoming a Full Service Partner (FLS) supervising the majority of tasks in the trial phases and the relations to medical

sites (Getz 2009). The CROs thereby both function as a mediator between pharmaceutical companies and new sites and assume the management of previous company relations. Even though some perspectives on brokering in the extant literature discuss the aim of brokerage (Gould and Fernandez 1989) research has yet to fully capturing the possible gains and consequences of this structure of knowledge flow. Mediator roles can also be observed in relation to a change in the structure of existing relations in a company's network, by integrating a third partner mediating existing relationships with the purpose of optimizing processes. The pharmaceutical industry is therefore an interesting example of an issue, which is not emphasized in extant literature on brokerage, where the third party function is changing existing network relations shifting them from direct to indirect ties. The integration of CRO partners thereby changes the network structure in down-stream processes, which generate implications for management.

MANAGERIAL IMPLICATIONS FOR DOWN-STREAM INNOVATION

In the presented literature on outsourcing in product development it is emphasized that a main motivation is a focused strategy on core competences. This however bring by the challenge of judging what the company's core competences are in the product development process (Howells 1999). It is previous mentioned in this paper, that a capability of large pharmaceutical companies in down-stream innovation is their financial capabilities relevant for the high risk phases, but also their experience in clinical trials and therefore knowledge on regulatory issues and embedded relationships with key actors such as the physicians (Danzon et al. 2005). When the relation to the medical sites are being moved to a third party agent the utilization of knowledge from the highly competent user at medical sites may be compromised. *The use of CROs to run clinical studies can make it more challenging for pharma companies to develop relationships with investigators* (Glass 2004 in Pharmaceutical Executive). The direct tie between sponsors and clinical sites may be jeopardized as the task of trial management are not perceived as a core competence and therefore moved to a third party agent. This may further create challenges to the absorptive capacity (Cohen and Levinthal 1990) of the sponsor company, as the clinical competences previously located in-house, are now located at the CRO. Getz (2007) studied the clinical in-house staff head count in the pharmaceutical industry and found a decrease of clinical staff, while the number of trials as well as R&D expenses increased. This decrease of in-house clinical staff occurred in a period, where the use of CRO activities highly increased.

It can be argued, that the absorptive capacity decrease, as the in-house specialists incorporated in the language of medical partners are being relocated to a third party. The interference of CROs challenges the opportunity to knowledge about the new products to be absorbed in the sponsor companies, as they are no longer directly connected to the trial sites, and as the CRO partners may not be as knowledgeable about the product as the in-house specialist working with the product for years. CROs often have multiple contracts in the industry simultaneously and are naturally not as integrated in the knowledge about new products build over many years of research and development as the in-house clinical staff. The absorptive capacity in CROs may therefore not be as profound as the sponsor company and so challenges the opportunities for absorbing knowledge and learning's by the physician partners, and further transferring this knowledge on to the pharmaceutical company. The flow of unique knowledge obtained in the clinical trial phases may therefore be compromised in the new structures of drug development. There is a gap in existing literature on this area. There are no studies on the pharmaceutical

industry focusing on this issue of drug development. The pharmaceutical industry is an example of an industry that has entered into a more network-oriented strategy in product development. However, it is also an example of an industry that may not fully be exploring the possibilities that exists in the unique relationship to down-stream external stakeholders of the NPD process. Late stage network partners are primarily perceived as providers of a necessary service in the testing of new products, who can supply concrete and pre-defined information of the clinical trials. However, these network partners, the medical centers, are highly qualified knowledge workers with in depth knowledge of the new product and the use of this. Knowledge, which exceeds the predefined formats and reporting systems, may not be discovered and therefore not explored by the industry in the following trials and market launch. This knowledge may often be characterized as tacit and this therefore needs to be considered in initiatives for tapping into this unique knowledge of the new products.

PROPOSITION 1

Broker agents have proven to improve drug development by optimizing time and costs of clinical research. However, these intermediary agents compromise valuable relations to network partners and therefore the knowledge flow between company and professional customers with unique knowledge in the product are.

Managerial implications for the down-stream product development processes need to be further explored and developed in order to capture the full potential of down-stream input from network resources. This requires ability to identify source of knowledge and how to tap into this knowledge and utilize it in the organization.

The example from the pharmaceutical industry illustrates a potential for down-stream input from users, which may not have been explored fully due to traditional perspectives on how network resources are utilized in down-stream NPD. Further, the increasing role of the CRO mediating the relation between users and company in late stage development imply that the importance of the relation to customers and the input firms may gain from this collaboration have not been fully explored.

PROPOSITION 2

Focus on external resources in late stage development requires management structures to capture the opportunities that may exist in individual industry product development processes. Further, these managerial tools should included aspects of the integration of broker functions and how these should be managed in order to optimize their potential and minimize consequences in relation to central external relations.

The propositions developed on the grounds of this paper will be further explored in an in-depth study of the knowledge possibilities at clinical sites in the pharmaceutical industry and an analysis of the initiatives engaged to tap into this knowledge. A study on the challenges to knowledge flow in down-stream product development in the pharmaceutical industry brought by an intermediary agent can generate knowledge about the industry, but also contribute to a gap in extant literature on down-stream network resources and the role of broker agents in late stage product development.

CONCLUDING REMARKS

This paper has explored the possibilities in down-stream network relations with emphasis on the role of users in late stage development. Examples of user inclusion in the pharmaceutical industry have illustrated that this central actor should not only be discussed in relation to knowledge input and resources in up-stream of innovation, but that users can be a key resource in down-stream processes. Further, the role of broker agents in down-stream networks have been discussed in relation to the changes this may create for the structure and relationship of the involved actors.

The role of users in down-stream innovation needs to be further explored, in order to understand the full influence of this actor and how optimal management tools can be integrated to utilize this potential. The pharmaceutical industry presents an interesting case, as it has been determined that the relation between industry and users are of great importance. However, further understanding of the actual character of this influence is needed as well as further possibilities of user influence not yet explored. A study on user influence in down-stream development can therefore both meet a gap in the literature on down-stream network influence in product development and contribute with further understanding of the role of broker agents in the network structure in late stage development.

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